ANALYSIS AND MEASUREMNET OF THE THROUGHPUT OF THE WLAN 802.11 OF K M SHAW HALL OF RESIDENCE NIT ROURKELA USING QUALNET

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF THE

REQUIREMENTS FOR THE DEGREE OF

Bachelor of Technology

In

Electronics and Instrumentaion Engineering

By

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NATIONAL INSTITUTE OF TECHNOLOGY

ROURKELA

CERTIFICATE

This is to certify that the thesis titled, **"Analysis and measurement of the throughput of Wlan 802.11a/b/g for KM SHAW Hall of residence NIT Rourkela using Qualnet "** submitted by **Divya Mehta** (Roll No : 10407021), **Meenakshi kumara** (Roll No : 10407032) in partial fulfillment for the award of Bachelor of Technology degree in **Electronics and Instrumentation Engineering ,** National Institute of Technology, Rourkela is an authentic work carried out by them under my supervision and guidance.

To the best of my knowledge, this matter embodied in the thesis has not been submitted at any other university / institute for the award of any Degree or Diploma.

Date:

Professor

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A C K N O W L E D G E M E N T

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CONTENTS

ABSTRACT

Wi-Fi sprang came into existence as a result of the decision of the federal communication commission(FCC) to open several wireless spectrum for use without a government license. In 1990, a new committee called 802.11 was set up to look into getting standard started. Today 802.11 is rapidly proliferating all over the planet.

Nonetheless it still faces number of technological challenges. A major one is the range the farthest the device can currently stray and still receive the signal from an 802.11 access point is about 300 feet ans if there are no major walls or building or substantial physical obstruction

Other major challenges is how to improve the data throughput speeds enhance security and quality of service. Throughput is the measure of the capacity of any communication channel.

Qualnet is a suitable tool for this project due to its easy-to-use user interface to the establish various graphs which are useful for camparison of the performance of the Wlan at different speed . A complete analysis have been carried out for performance of the Wlan at speed support by 802.11b standard 1Mbps,2Mbps,5.5Mbps and 11Mbps, also energy consumption, total number of bytes sent and received.

KEYWORDS WLAN , 802.11, 802.11b,THROUGHPUT

LIST OF FIGURES:

Introduction

Wireless network refers to any type of computer network that is wireless, and is commonly associated with a telecommunications network whose interconnections between nodes is implemented without the use of wires, such as a computer network (a type of communications network). Wireless telecommunications networks are generally implemented with some type of remote information transmission system that uses electromagnetic waves, such as radio waves, for the carrier and this implementation usually takes place at the physical level or "layer" of the network.[

Types:

Wireless LAN: Wireless Local Area Network (WLAN) is similar to other wireless devices and uses radio instead of wires to transmit data back and forth between computers on the same network.

Wi-Fi: Wi-Fi is a commonly used wireless network in computer systems which enable connection to the internet or other machines that have Wi-Fi functionalities. Wi-Fi networks broadcast radio waves that can be picked up by Wi-Fi receivers that are attached to different computers or mobile phones.

Fixed Wireless Data: Fixed wireless data is a type of wireless data network that can be used to connect two or more buildings together in order to extend or share the network bandwidth without physically wiring the buildings together.

Wireless MAN: Wireless are type of wireless network that connects several Wireless LANs. WiMAX **is** the term used to refer to wireless MANs and is covered in IEEE 802.16d/802.16e.

Mobile devices networks:

Global System for Mobile Communications (GSM): The GSM network is divided into three major systems which are: the switching system, the base station system, and the operation and support system (Global System for Mobile Communication (GSM)). The cell phone connects to the base system station which then connects to the operation and support station; it then connects to the switching station where the call is transferred where it needs to go (Global System for Mobile Communication (GSM)). This is used for cellular phones, is the most common standard and is used for a majority of cellular providers.

Personal Communications Service (PCS): PCS is a radio band that can be used by mobile phones in North America. Sprint happened to be the first service to set up a PCS.

D-AMPS: D-AMPS, which stands for Digital Advanced Mobile Phone Service, is an upgraded version of AMPS but it is being phased out due to advancement in technology. The newer GSM networks are replacing the older system.

Network simulators:

Network simulators are important tools for research in wireless networks. Network simulators model the different layers of a communication stack. Although developers of network simulators aim to model the network as realistically as possible, simulations can not always predicts the reality. Testing a newly developed protocol in a real-world tested is an indispensable step before deployment. However, simulations have some advantages compared to real-world tests. Simulations are fast, cheap, reproducible and allow parameter isolation. Therefore, research organizations, universities and commercial companies have made a large effort to develop sophisticated network simulator software.

Types:

The Network Simulator:

The network simulator (often called ns-2) [35] is a popular event based network for academic research. The simulator software is written in C++.Simulation parameters are scripted in OTcl, an object oriented extension of the programming language Tcl .For each object in C++ there exists a corresponding Tcl-object which makes it possible to access and modify simulation properties during the simulation. The Network Animator (NAM) tool [36] distributed as a separate application enables to visualize mobility and packet traces produced during simulation in ns-2.

Global Mobile information system simulation library (GloMoSim)

GloMoSim [37] is a library foe sequential and parallel simulation or wireless networks developed by Parallel Computing Laboratory at the University of California in Los Angeles. It is based on PARSEC, a compiler for a C-based parallel simulation language. An extensible set of library models specific communication protocols in the network protocols stack.

Qualnet:

Qualnet[38] is a commercial network simulator developed by Scalable Network Technologies as the successor of GloMoSim.It is available for various operating systems(Microsoft Windows , Linux , Mac OS X ,Sun Solaris) and supports parallel computing environments. Qualnet offers highly detailed models and can be extended with user – defined modules. The Qualnet product family offers graphical tools to design, run and analyze simulation scenarios.

OPNET:

OPNET [39] is a commercial network simulator which models communication devices and protocols and offers a large variety of built-in analysis tools. It is mainly for the simulation of the network designs, to evaluate the influences of changes in the network and the configuration of the network.

Chapter 1

Wireless LAN

1.1 Definition

1.2 Advantages

1.3 Disadvantages

1.4 Architecture

1.5 Types

1.1 Definition:

A **wireless LAN** or **WLAN** is a wireless local area network, which is the linking of two or more computers without using wires.

WLAN utilizes spread-spectrum or OFDM modulation technology based on radio waves to enable communication between devices in a limited area, also known as the basic service set. This gives users the mobility to move around within a broad coverage area and still be connected to the network.

For the home user, wireless has become popular due to ease of installation, and location freedom with the gaining popularity of laptops. Public businesses such as coffee shops or malls have begun to offer wireless access to their customers; some are even provided as a free service. Large wireless network projects are being put up in many major cities. Google is even providing a free service to Mountain View, California and has entered a bid to do the same for San Francisco. New York City has also begun a pilot program to cover all five boroughs of the city with wireless Internet access.

1.2 Advantages:

Convenience: The wireless nature of such networks allows users to access network resources from nearly any convenient location within their primary networking environment (home or office).

Mobility: With the emergence of public wireless networks, users can access the internet even outside their normal work environment. Most chain coffee shops, for example, offer their customers a wireless connection to the internet at little or no cost.

Productivity: Users connected to a wireless network can maintain a nearly constant affiliation with their desired network as they move from place to place. For a business, this implies that an employee can potentially be more productive as his or her work can be accomplished from any convenient location.

Deployment**:** Initial setup of an infrastructure-based wireless network requires little more than a single access point. Wired networks, on the other hand, have the additional cost and complexity of actual physical cables being run to numerous locations (which can even be impossible for hard-to-reach locations within a building).

Expandability: Wireless networks can serve a suddenly-increased number of clients with the existing equipment. In a wired network, additional clients would require additional wiring.

Cost: Wireless networking hardware is at worst a modest increase from wired counterparts. This potentially increased cost is almost always more than outweighed by the savings in cost and labor associated to running physical cables.

1.3 Disadvantages

Security: Wireless LAN transceivers are designed to serve computers throughout a structure with uninterrupted service using radio frequencies. Because of space and cost, the antennas typically present on wireless networking cards in the end computers are generally relatively poor. In order to properly receive signals using such limited antennas throughout even a modest area, the wireless LAN transceiver utilizes a fairly considerable amount of power. What this means is that not only can the wireless packets be intercepted by a nearby adversary's poorly-equipped computer, but more importantly, a user willing to spend a small amount of money on a good quality antenna can pick up packets at a remarkable distance; perhaps hundreds of times the radius as the typical user. In fact, there are even computer users dedicated to locating and sometimes even cracking into wireless networks, known as war drivers. On a wired network, any adversary would first have to overcome the physical limitation of tapping into the actual wires, but this is not an issue with wireless packets. To combat this consideration, wireless networks users usually choose to utilize various encryption technologies available such as Wi-Fi Protected Access (WPA). Some of the older encryption methods, such as WEP are known to have weaknesses that a dedicated adversary can compromise.

Range**:** The typical range of a common 802.11g network with standard equipment is on the order of tens of meters. While sufficient for a typical home, it will be insufficient in a larger structure. To obtain additional range, repeaters or additional access points will have to be purchased. Costs for these items can add up quickly.

Reliability: Like any radio frequency transmission, wireless networking signals are subject to a wide variety of interference, as well as complex propagation effects (such as multipath, or especially in this case Rician fading) that are beyond the control of the network administrator. One of the most insidious problems that can affect the stability and reliability of a wireless LAN is the microwave oven. In the case of typical networks, modulation is achieved by complicated forms of phase-shift keying (PSK) or quadrature amplitude modulation (QAM), making interference and propagation effects all the more disturbing. As a result, important network resources such as servers are rarely connected wirelessly.

Speed: The speed on most wireless networks (typically 1-108 Mbit/s) is reasonably slow compared to the slowest common wired networks (100 Mbit/s up to several Gbit/s). There are also performance issues caused by TCP and its built-in congestion avoidance. For most users, however, this observation is irrelevant since the speed bottleneck is not in the wireless routing but rather in the outside network connectivity itself. For example, the maximum ADSL throughput (usually 8 Mbit/s or less) offered by telecommunications companies to general-purpose customers is already far slower than the slowest wireless network to which it is typically connected. That is to say, in most environments, a wireless network running at its slowest speed is still faster than the internet connection serving it in the first place. However, in specialized environments, higher throughput through a wired network might be necessary. Newer standards such as 802.11n are addressing this limitation and will support peak throughputs in the range of 100-200 Mbit/s

1.4 Architecture

Stations

All components that can connect into a wireless medium in a network are referred to as stations. All stations are equipped with wireless network interface cards (WNICs). Wireless stations fall into one of two categories: access points, and clients. Access points (APs) are base stations for the wireless network. They transmit and receive radio frequencies for wireless enabled devices to communicate with.

Wireless clients can be mobile devices such as laptops, personal digital assistants, IP phones, or fixed devices such as desktops and workstations that are equipped with a wireless network interface.

Basic service set

The basic service set (BSS) is a set of all stations that can communicate with each other.

There are two types of BSS: Independent BSS (also referred to as IBSS), and infrastructure BSS. Every BSS has an identification (ID) called the BSSID, which is the MAC address of the access point servicing the BSS. An independent BSS (IBSS) is an ad-hoc network that contains no access points, which means they can not connect to any other basic service set. An infrastructure BSS can communicate with other stations not in the same basic service set by communicating through access points.

Extended service set

An extended service set (ESS) is a set of connected BSSes. Access points in an ESS are connected by a distribution system. Each ESS has an ID called the SSID which is a 32-byte (maximum) character string. For example, "linksys" is the default SSID for Linksys routers.

Distribution system

A distribution system connects access points in an extended service setup. The concept of a DS can be to increase network coverage through roaming between cell's.

1.5 Types

Peer –to-Peer:

A peer-to-peer (P2P) allows wireless devices to directly communicate with each other. Wireless devices within range of each other can discover and communicate directly without involving central access points. This method is typically used by two computers so that they can connect to each other to form a network.

Bridge:

A bridge can be used to connect networks, typically of different types. A wireless Ethernet bridge allows the connection of devices on a wired Ethernet network to a wireless network.

Wireless Distribution System:

It is a system that enables the wireless interconnection of access points in an IEEE 802.11 network. It allows a wireless network to be expanded using multiple access points without the need for a wired backbone to link them, as is traditionally required. The notable advantage of WDS over other solutions is that it preserves the MAC addresses of client packets across links between access points. s network. The bridge acts as the connection point to the Wireless LAN

Chapter 2

Wireless Standards

2.1 Introduction

2.2 Types-

- **2.2.1 802.11b**
- **2.2.1 802.11a**
- **2.2.3 802.11g**
- **2.2.4 802.11n**

2.1 Introduction

Home and business networkers looking to buy wireless local area network (WLAN) gear face an array of choices. Many products conform to the **802.11a**, **802.11b**, **802.11g**, or **802.11n** wireless standards collectively known as Wi-Fi technologies. Additionally, **Bluetooth** and various other non Wi-Fi technologies also exist, each also designed for specific networking applications.

In 1997, the Institute of Electrical and Electronics Engineers (IEEE) created the first WLAN standard. They called it *802.11* after the name of the group formed to oversee its development.

Unfortunately, 802.11 only supported a maximum network bandwidth of 2 Mbps - too slow for most applications. For this reason, ordinary 802.11 wireless products are no longer manufactured

2.2 Types:

2.2.1 802.11b

IEEE expanded on the original 802.11 standard in July 1999, creating the *802.11b* specification. 802.11b supports bandwidth up to 11 Mbps, comparable to traditional Ethernet.

802.11b uses the same *unregulated* radio signaling frequency (2.4 GHz) as the original 802.11 standard. Vendors often prefer using these frequencies to lower their production costs. Being unregulated, 802.11b gear can incur interference from microwave ovens, cordless phones, and other appliances using the same 2.4 GHz range. However, by installing 802.11b gear a reasonable distance from other appliances, interference can easily be avoided.

- **Pros of 802.11b** - lowest cost; signal range is good and not easily obstructed
- **Cons of 802.11b** - slowest maximum speed; home appliances may interfere on the unregulated frequency band

2.2.2 802.11a

While 802.11b was in development, IEEE created a second extension to the original 802.11 standard called *802.11a*. Because 802.11b gained in popularity much faster than did 802.11a, some folks believe that 802.11a was created after 802.11b. In fact, 802.11a was created at the same time. Due to its higher cost, 802.11a is usually found on business networks whereas 802.11b better serves the home market.

802.11a supports bandwidth up to 54 Mbps and signals in a regulated frequency spectrum around 5 GHz. This higher frequency compared to 802.11b shortens the range of 802.11a networks. The higher frequency also means 802.11a signals have more difficulty penetrating walls and other obstructions.

Because 802.11a and 802.11b utilize different frequencies, the two technologies are incompatible with each other. Some vendors offer hybrid **802.11a/b** network gear, but these products merely implement the two standards side by side (each connected devices must use one or the other).

- **<u>Pros of 802.11a</u>** - fast maximum speed; regulated frequencies prevent signal interference from other devices
- **<u>Cons of 802.11a</u>** - highest cost; shorter range signal that is more easily obstructed

2.2.3 802.11g

In 2002 and 2003, WLAN products supporting a newer standard called *802.11g* emerged on the market. 802.11g attempts to combine the best of both 802.11a and 802.11b. 802.11g supports bandwidth up to 54 Mbps, and it uses the 2.4 GHz frequency for greater range. 802.11g is backwards compatible with 802.11b, meaning that 802.11g access points will work with 802.11b wireless network adapters and vice versa.

❖ **<u>Pros of 802.11g</u>** - fast maximum speed; signal range is good and not easily obstructed

❖ **<u>Cons of 802.11g</u>** - costs more than 802.11b; appliances may interfere on the unregulated signal frequency.

2.2.4 802.11n

The newest IEEE standard in the Wi-Fi category is *802.11n*. It was designed to improve on 802.11g in the amount of bandwidth supported by utilizing multiple wireless signals and antennas (called *MIMO* technology) instead of one.

❖ **Pros of 802.11n** - fastest maximum speed and best signal range; more resistant to signal interference from outside sources

❖ **Cons of 802.11n** - standard is not yet finalized; costs more than 802.11g; the use of multiple signals may greatly interfere with nearby 802.11b/g based networks

Chapter 3

Qualnet Simulation

3.1 Definition

3.2 Qualnet Development Tools

3.3 Job given.

3.4 Simulations

3.1 Definition:

QualNet provides a comprehensive environment for designing protocols, creating and animating experiments, and analyzing the results of those experiments.

3.2 Qualnet Developer Tools:

QualNet Developer is composed of the following tools:

- **QualNet Scenario Designer—**a graphical experiment design tool.
- **QualNet Animator—**A graphical experiment animation tool.
- **QualNet Analyzer—**A graphical statistical analyzing tool.
- **QualNet Tracer—**A graphical packet tracing tool.
- **QualNet 3D Visualizer—**A 3D graphical imaging tool.
- **QualNet Simulator—** A network simulator tool.

3.3 Job given:

To establish Wireless LAN in Ladies Hall(Block-A) NIT Rourkela and to analyze its performance by measuring the **Throughput** ,at different speeds and by transferring files of different size between the FTP server (access point) and the nodes.

Throughput is the rate at which a computer or network sends or receives data. It therefore is a good measure of the channel capacity of a communications link, and connections to the internet are usually rated in terms of how many bits they pass per second (bit/s). Responsiveness has far less to do with throughput than latency.

3.4 Simulation:

Throughput obtained at different speeds (1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps), placing only one access point in the building. The analysis is carried out for ground floor and firs floor of the building separately. Here simulation is performed for by varying the number of the data items sent. The autocad design is helpul in placing the nodes at specific distance and position.

Case 1: No. of data items sent = 100

Since, 1 data item = 512 bits

Therefore, no. of data items sent in KiloBytes = 6.25 KB

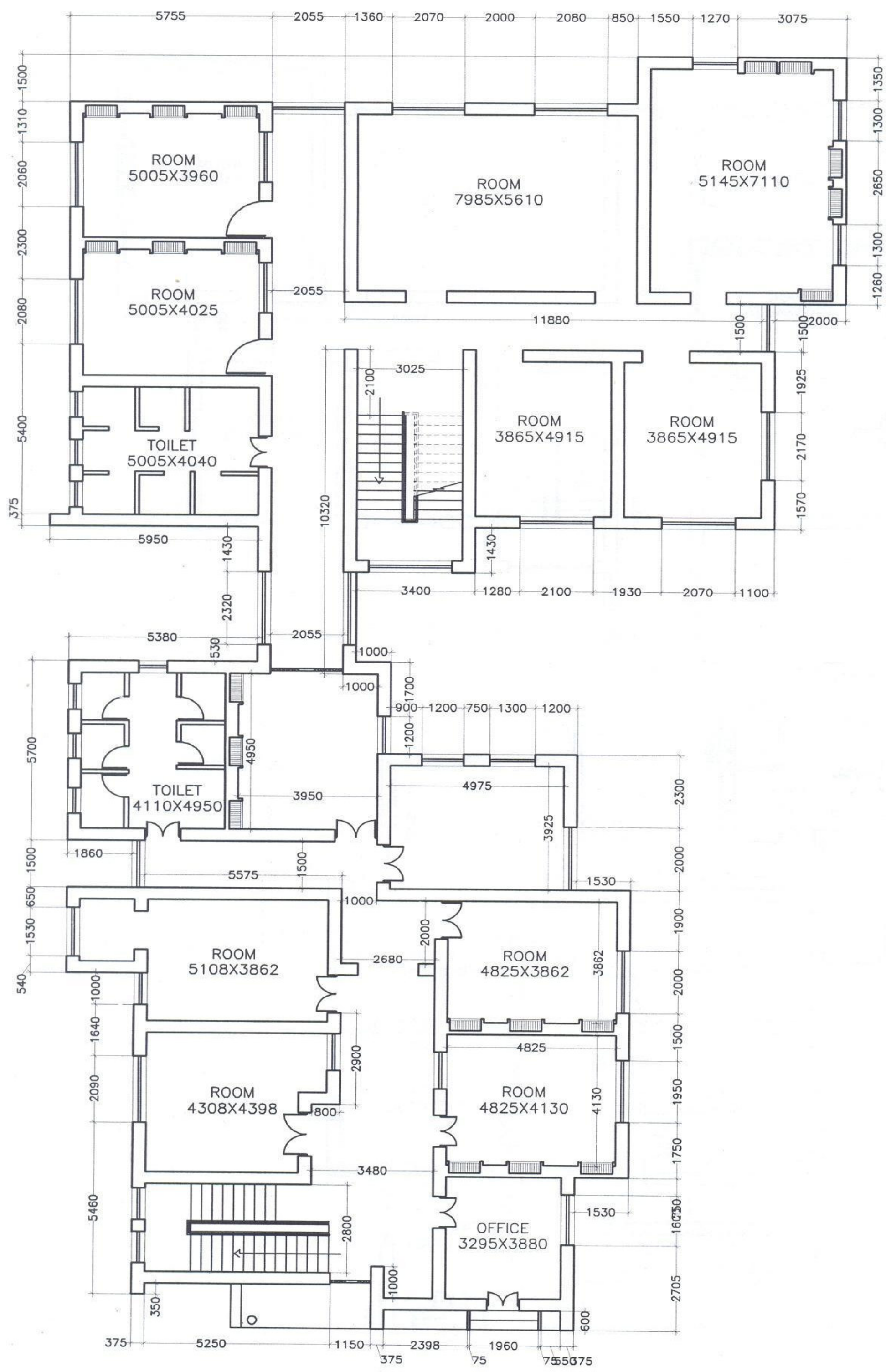

Fig: 3.1 **<u>Auto cad design of the ground floor KM SHAW hall of residence</u>**

Ground floor:

Speed = 1 Mbps

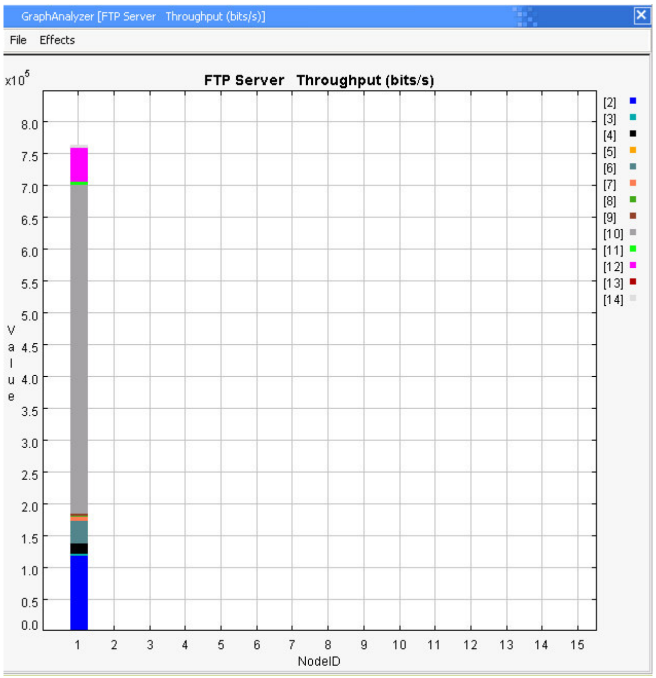

Fig. 3.2 **FTP Server Throughput**

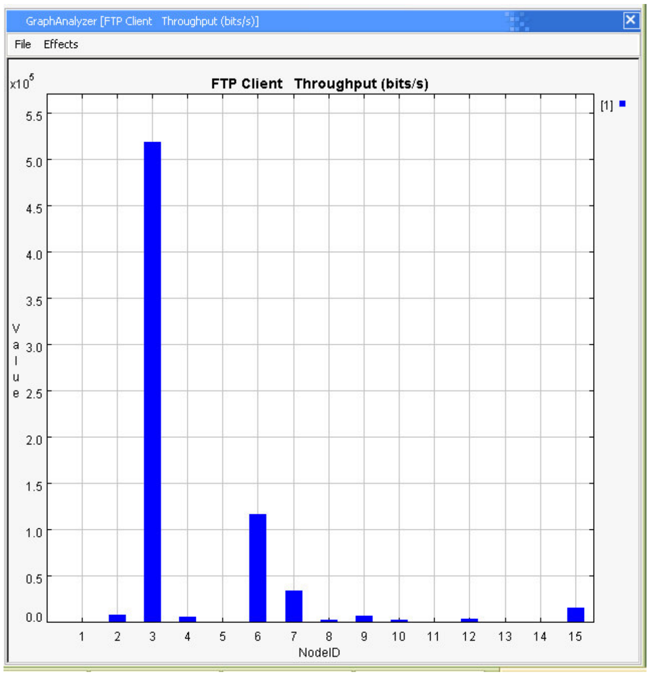

Fig. 3.3 **FTP Client Throughput**

Speed = 2 Mbps

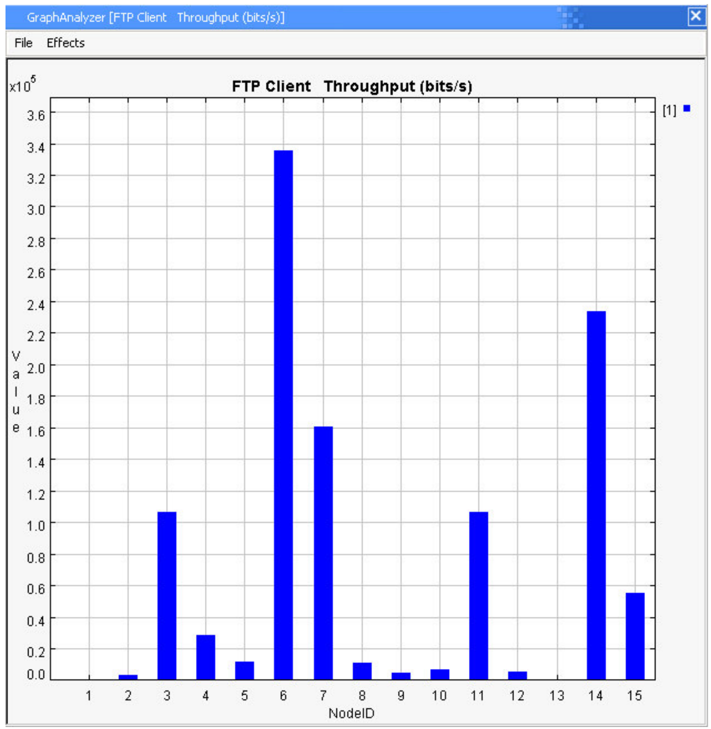

Fig. 3.4**<u>FTP Client throughput</u>**

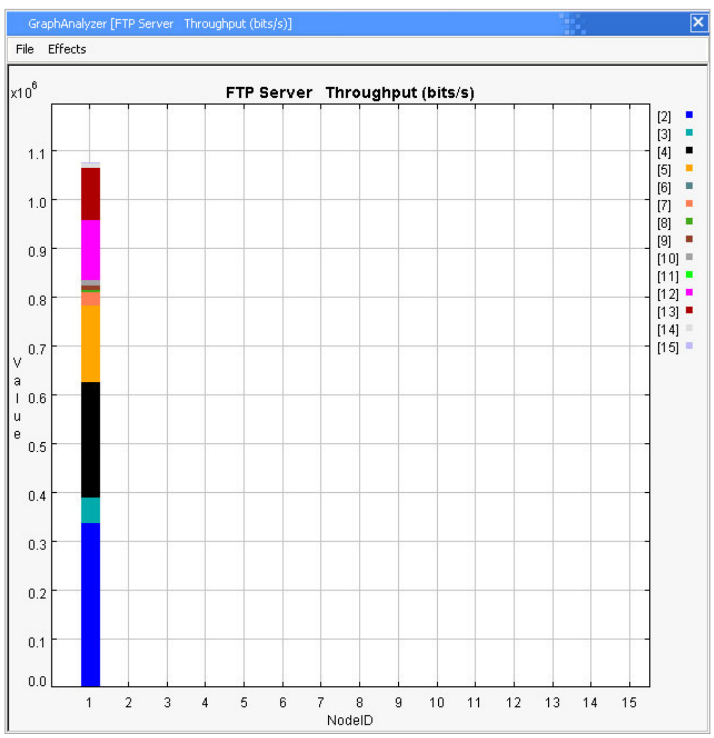

Fig. 3.5 **<u>FTP Server throughput</u>**

Speed=5.5 Mbps

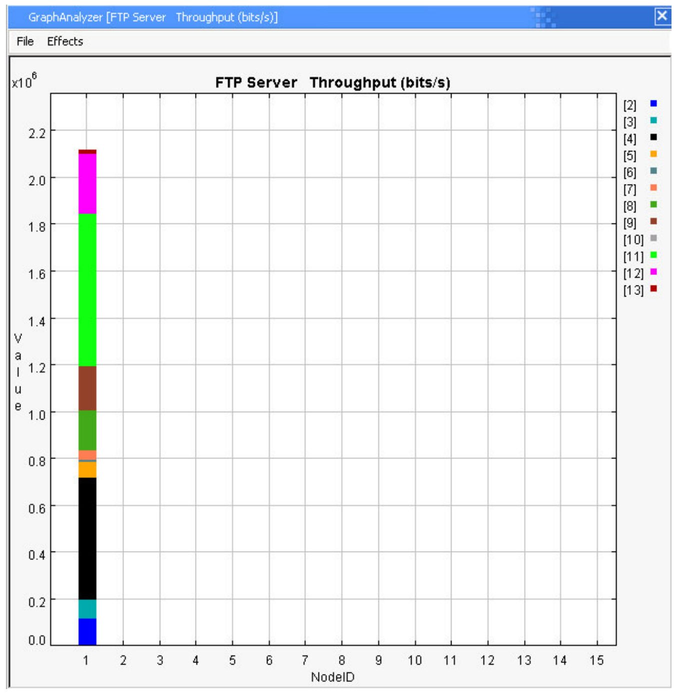

Fig. 3.6 **FTP Server Throughput**

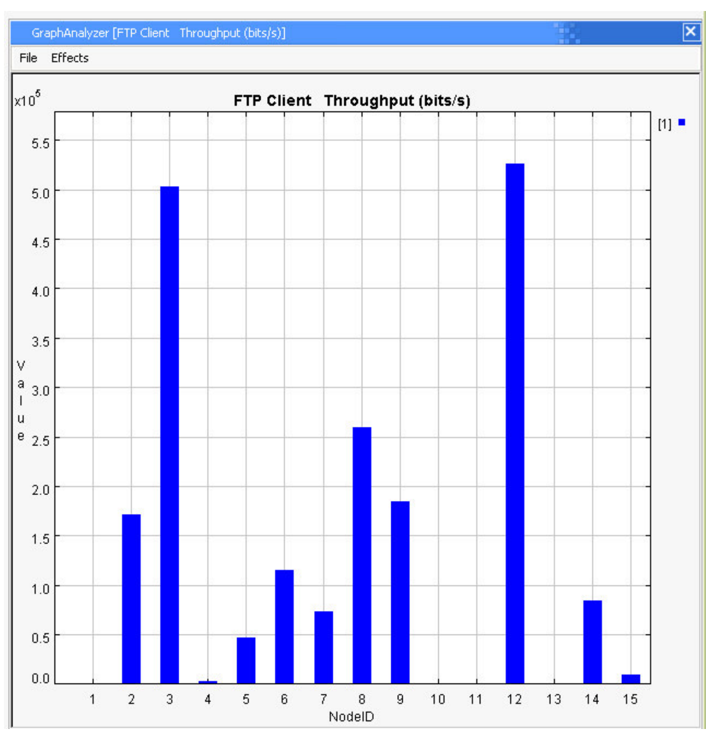

Fig.3.7**FTP Client Throughput**

Speed =11 Mbps

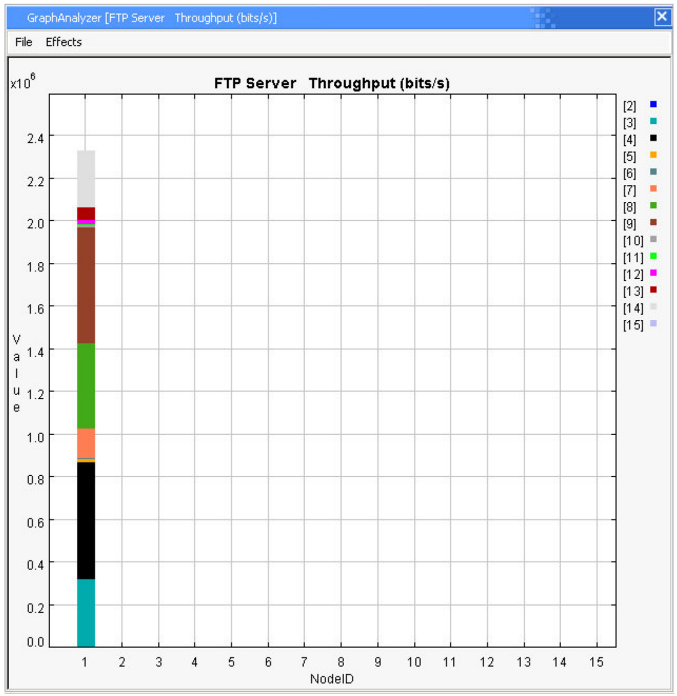

Fig. 3.8 **FTP Server Throughput**

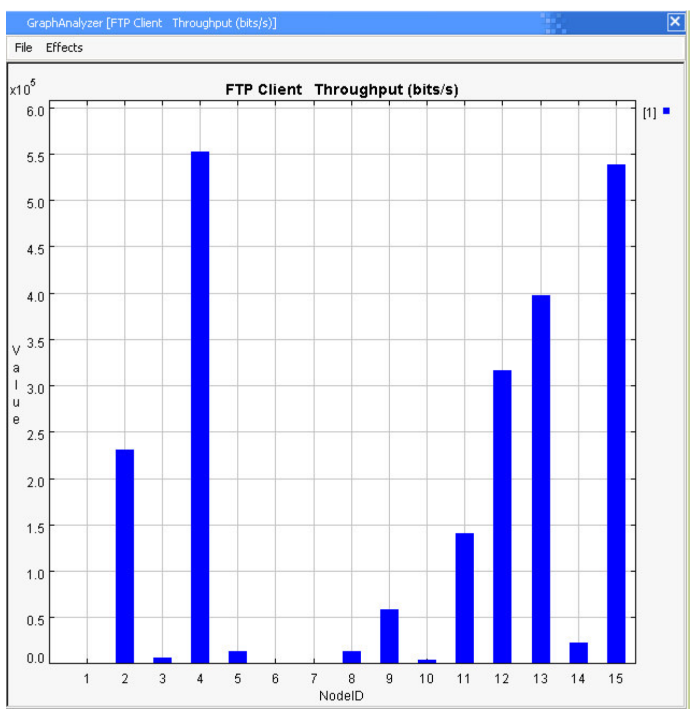

Fig.3.9 **FTP Client Throughput**

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Analysis

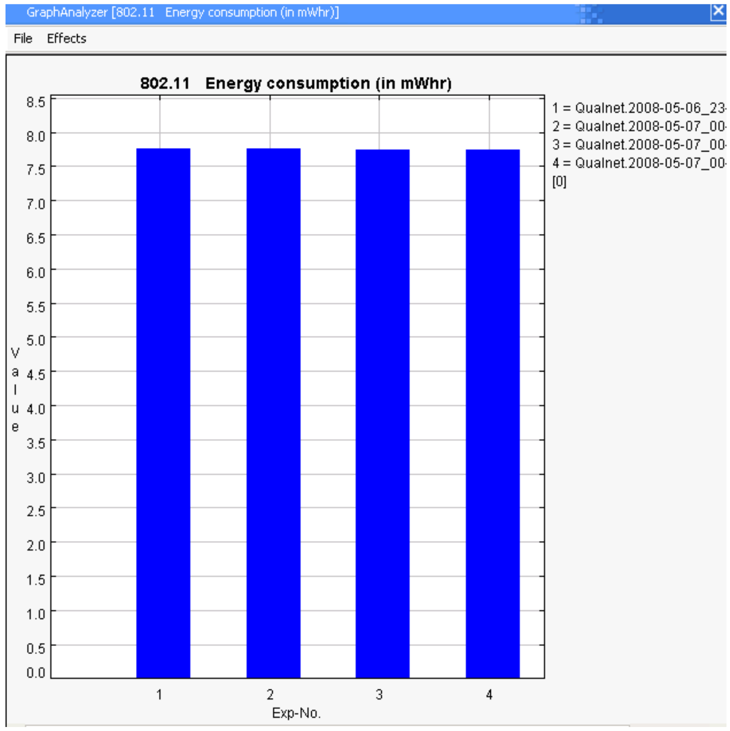

Fig 3.10 **Energy Consumption**

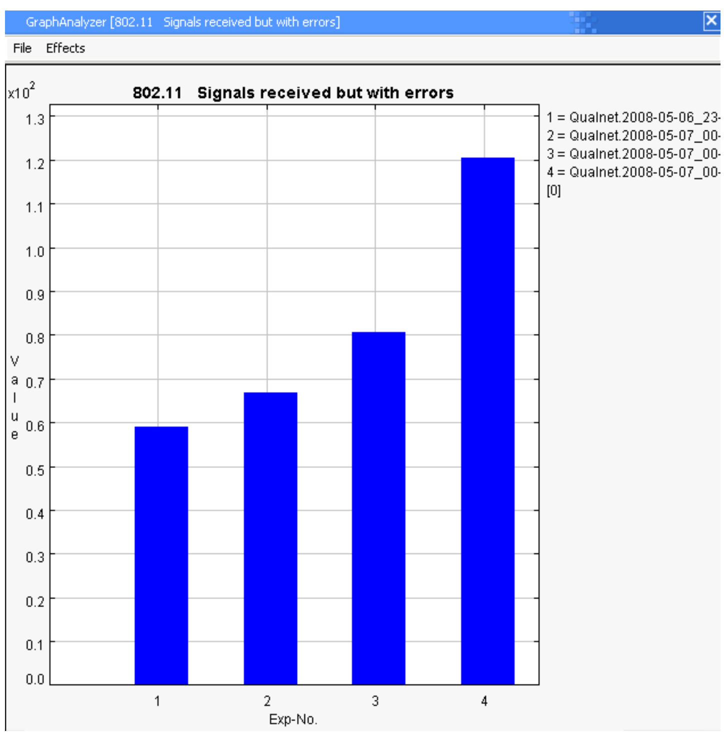

Fig 3.11 **Signals received (with error)**

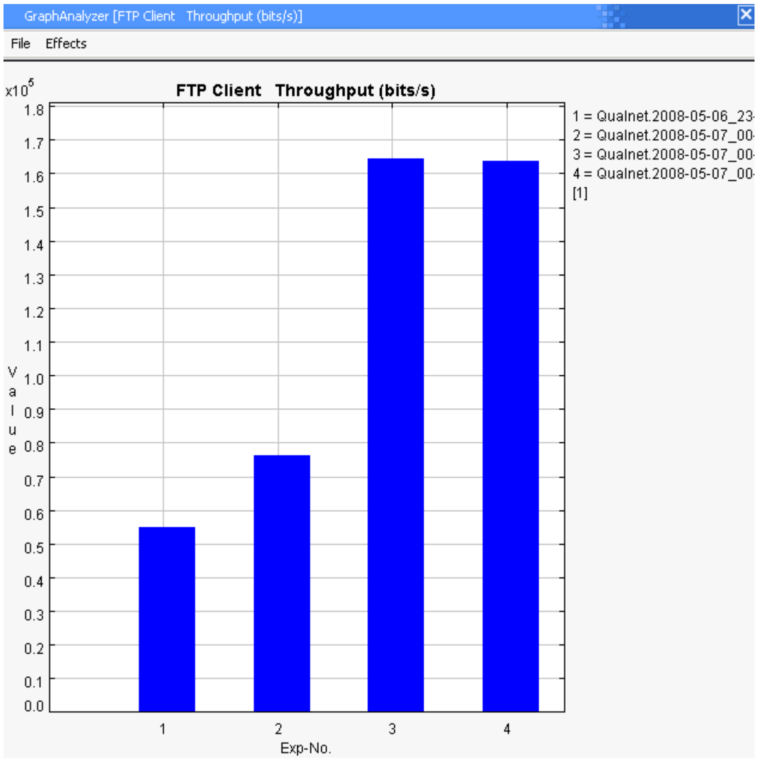

Fig 3.12**<u>FTP Client Throughput</u>**

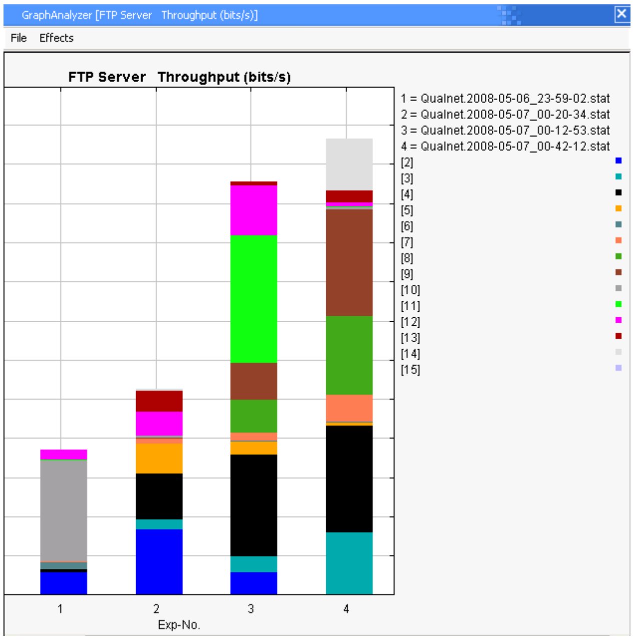

Fig 3.13 **<u>FTP Server Throughput</u>**

<u>Note:</u> here 1= 1Mbps, 2= 2 Mbps , 3= 5.5 Mbps and 4= 11 Mbps.

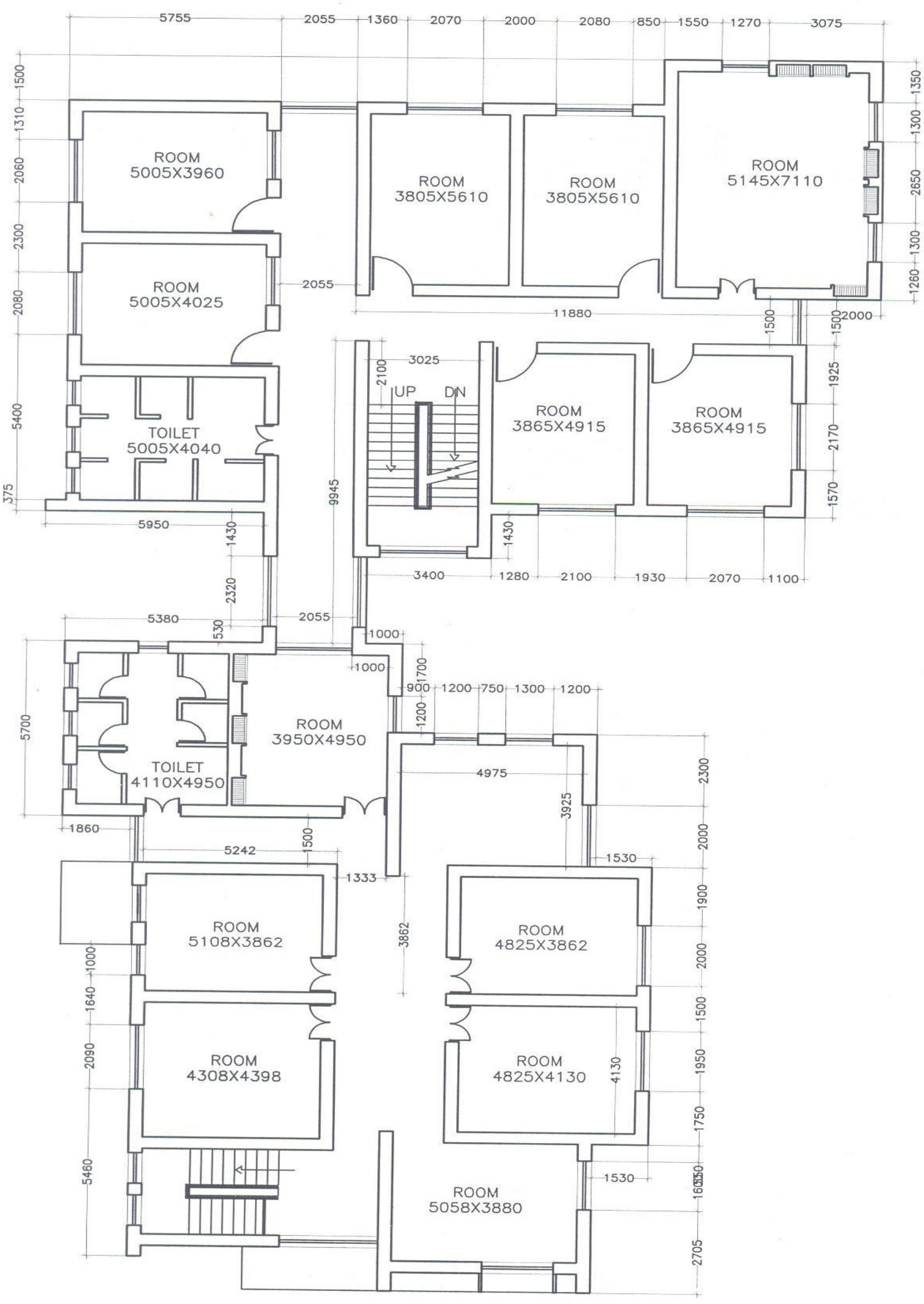

Fig : 3.14 **<u>Autocad design of the First floor K M SHAW Hall of residence</u>**

1st floor:

Speed= 1 Mbps

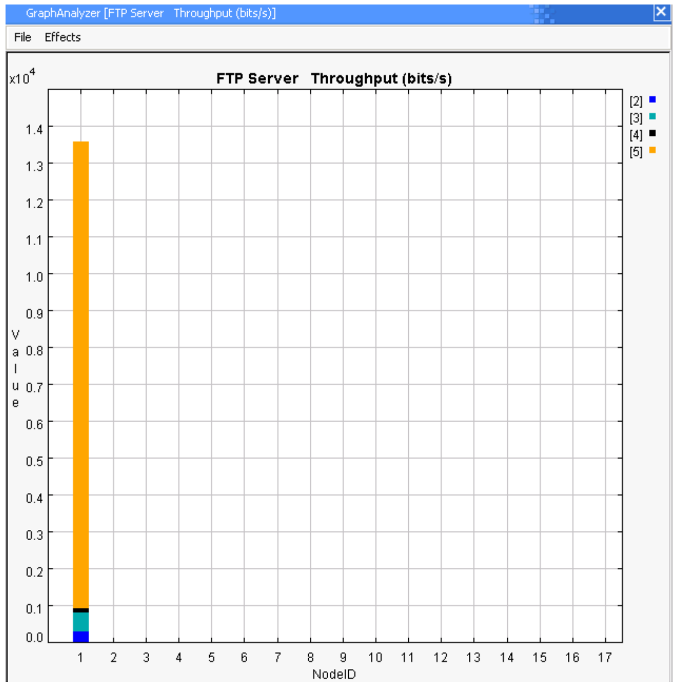

Fig. 3.15**FTP Server Throughput**

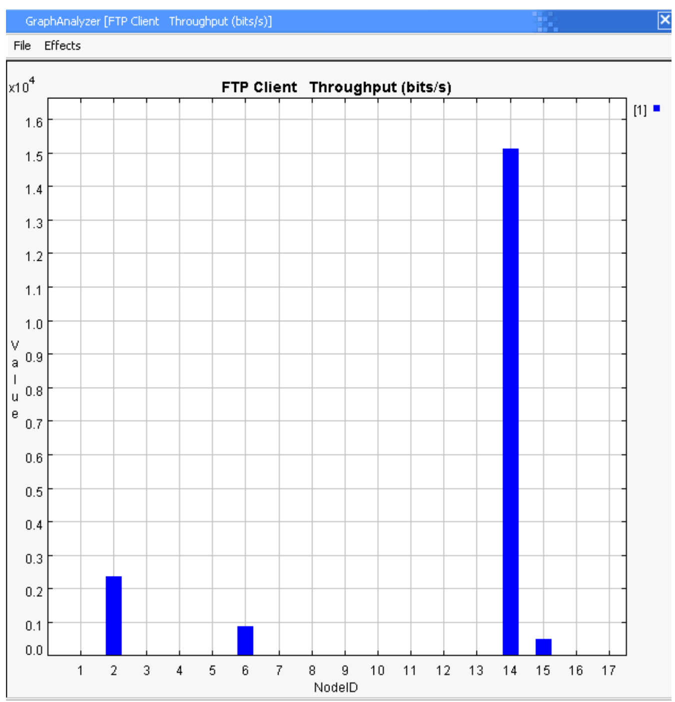

Fig 3.16**FTP Client Throughput**

Speed = 2 Mbps

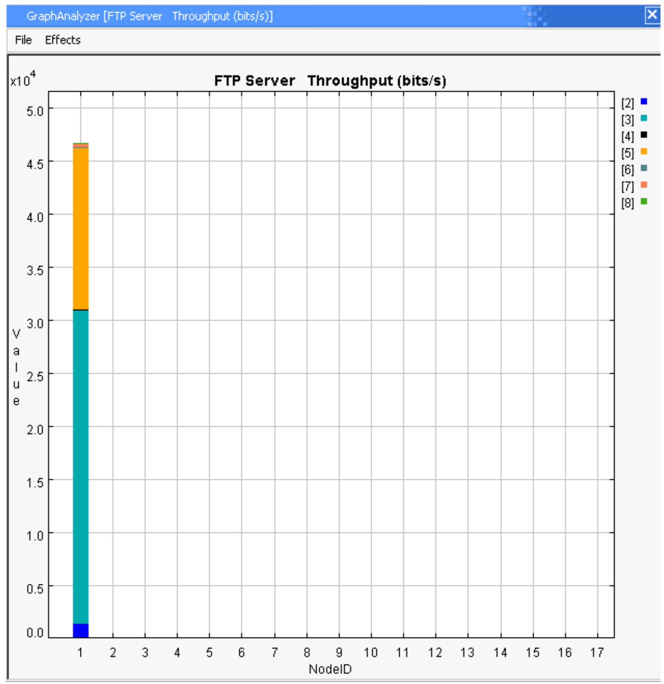

Fig 3.17 **FTP Server Throughput**

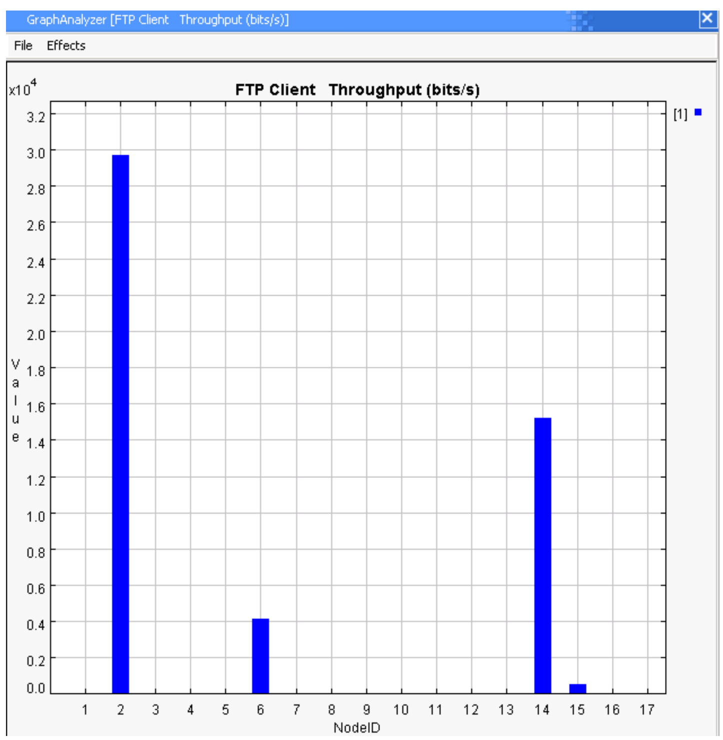

Fig 3.18 **FTP Client Throughput**

Speed = 5.5 Mbps

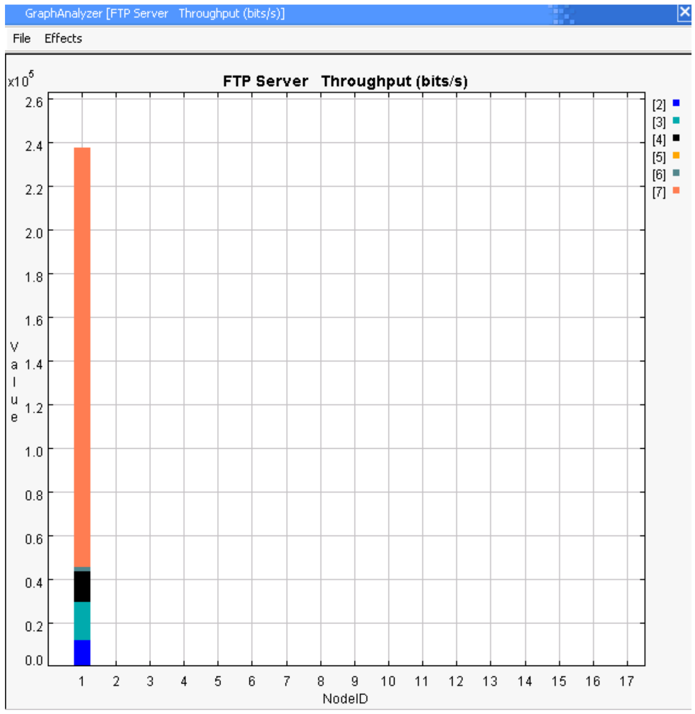

Fig 3.19 **FTP Server Throughput**

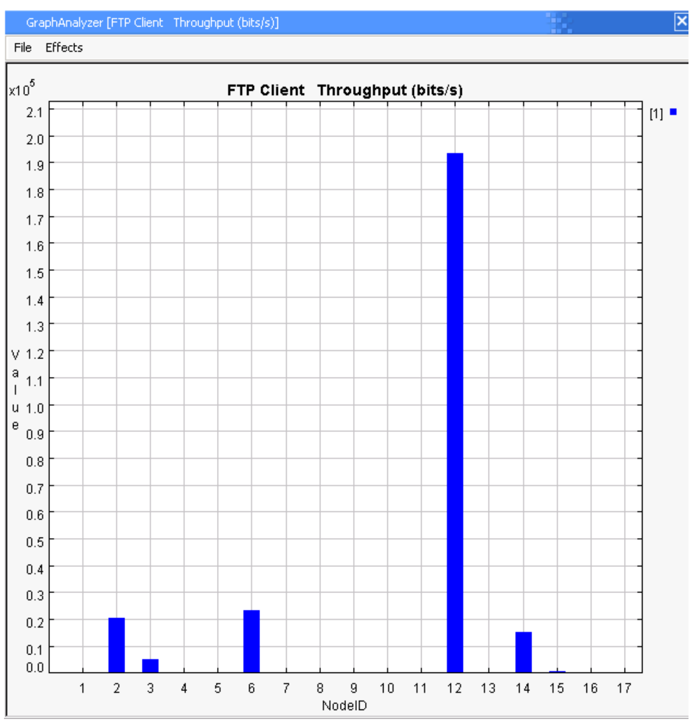

Fig 3.20 **FTP Client Throughput**

Speed = 11 Mbps

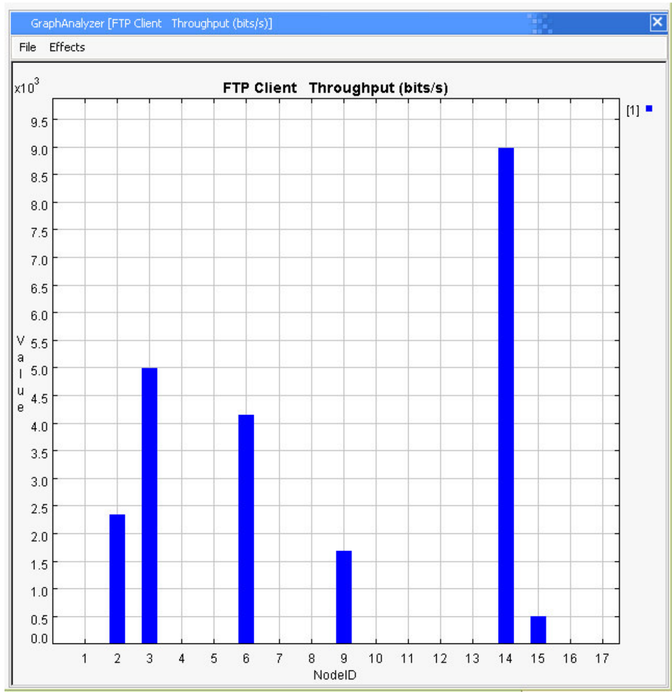

Fig 3.21 **FTP Client Throughput**

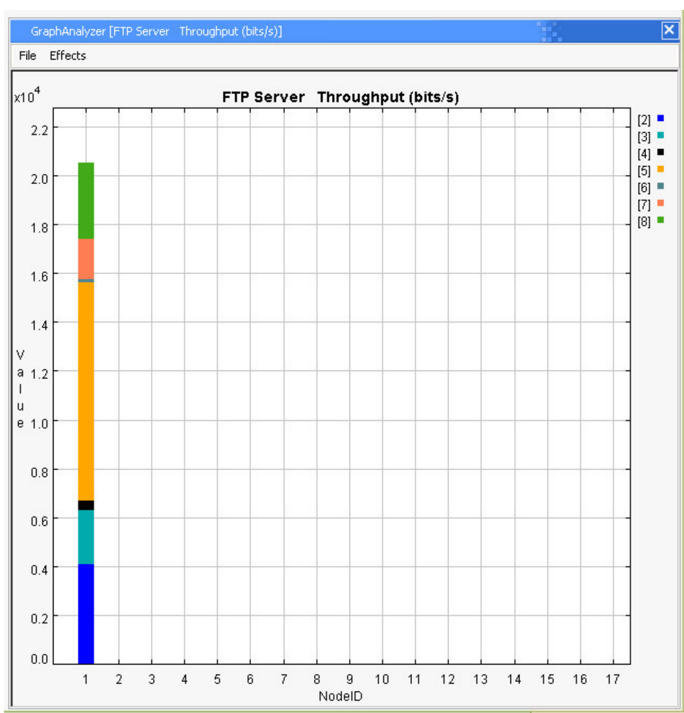

Fig 3.22 **FTP Server Throughput**

ANALYSIS:

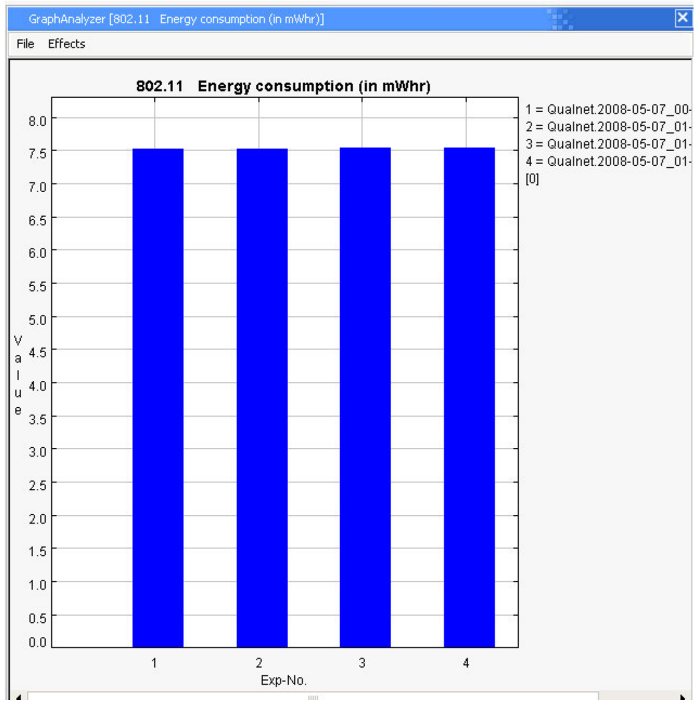

Fig 3.23 **Energy Consumption**

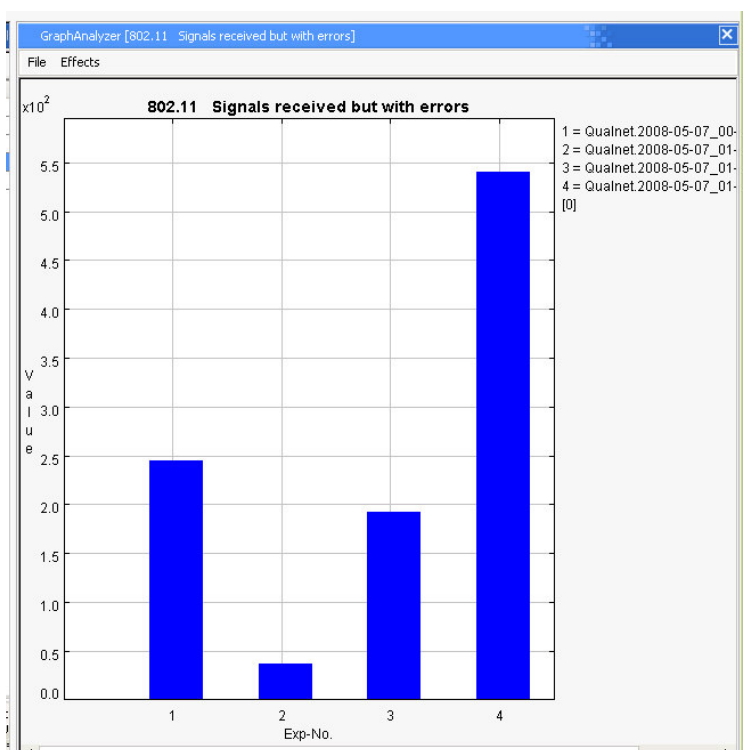

Fig 3.24 **Signals received (with error)**

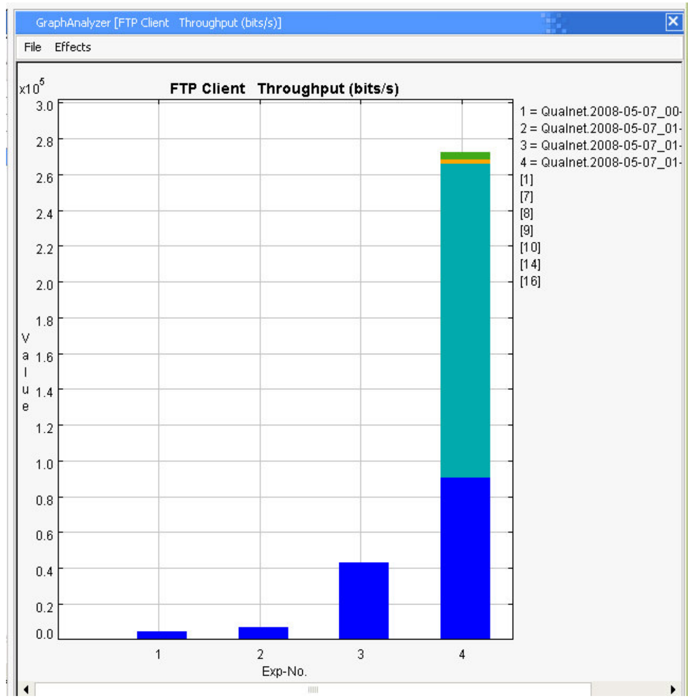

Fig 3.25 **FTP Client Throughput**

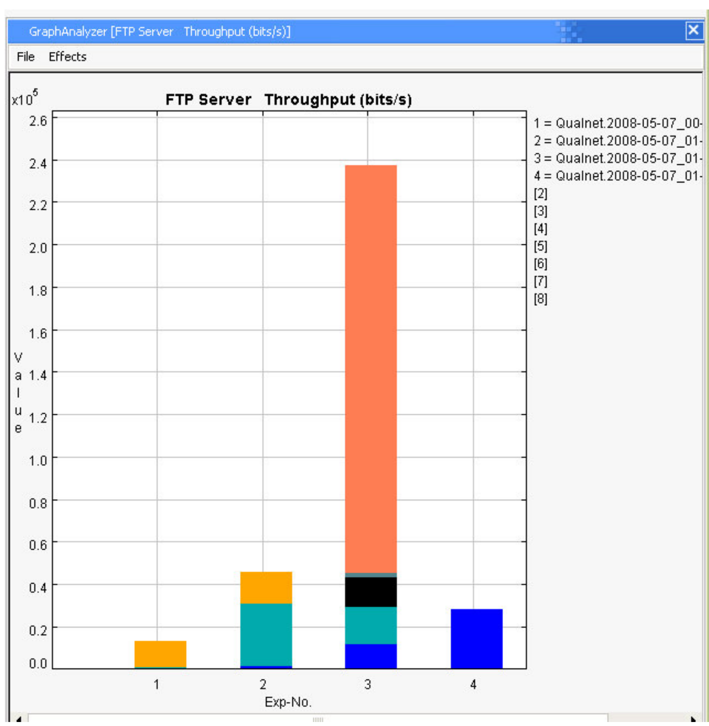

Fig 3.26 **FTP Server Throughput**

Note: here 1= 1Mbps, 2= 2 Mbps , 3= 5.5 Mbps and 4= 11 Mbps.

<u>Case2:</u> NO data items to be sent is 10000

For , I data item=512 bits.

Therefore, no. of data items in Bytes= 4.8 MB

Ground floor:

Speed=1 Mbps

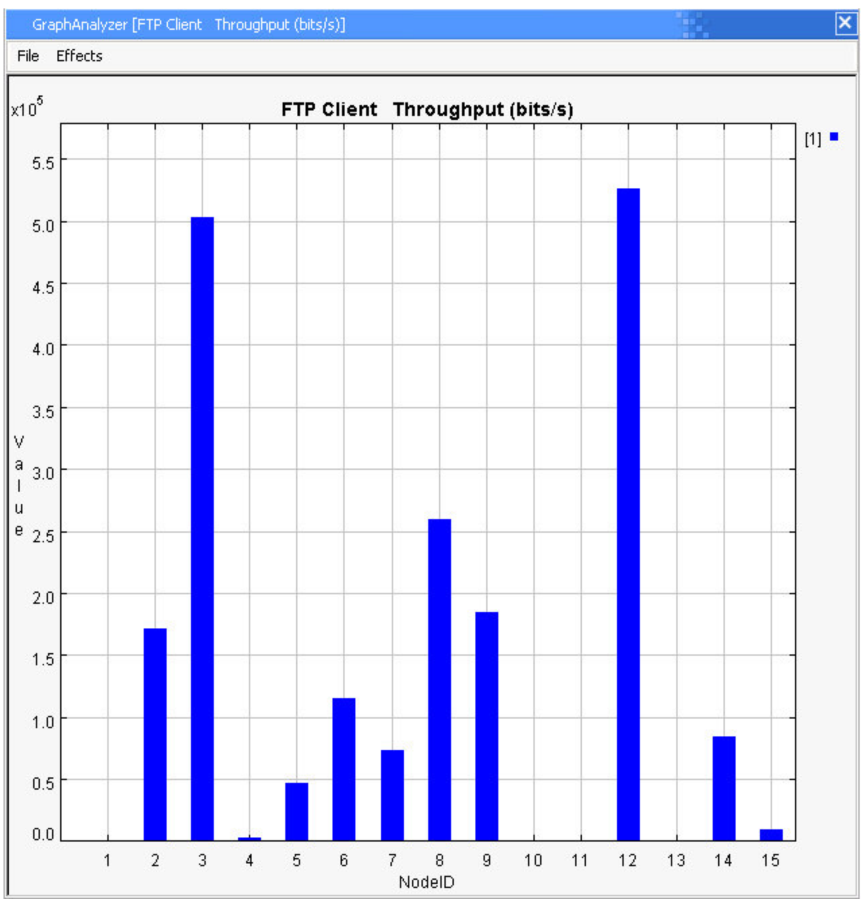

Fig 3.27 **<u>FTP Client Throughput</u>**

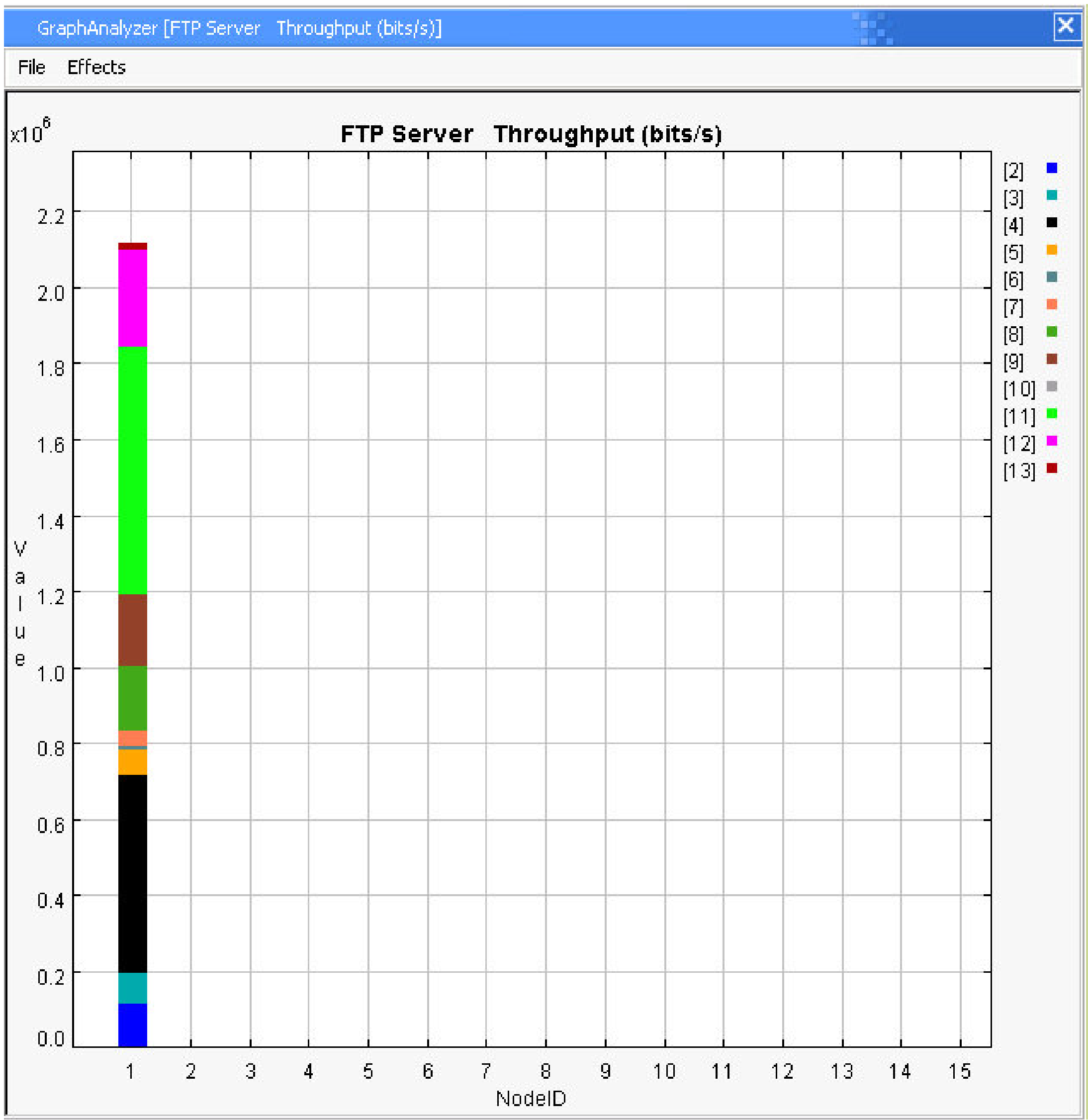

Fig 3.28 **FTP Server Throughput**

speed=2Mbps

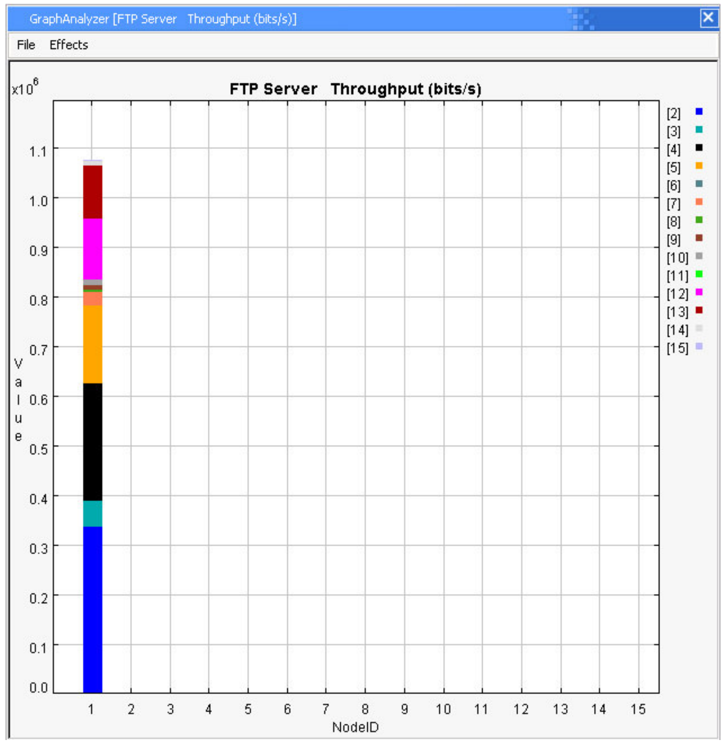

Fig 3.29 **FTP Server Throughput**

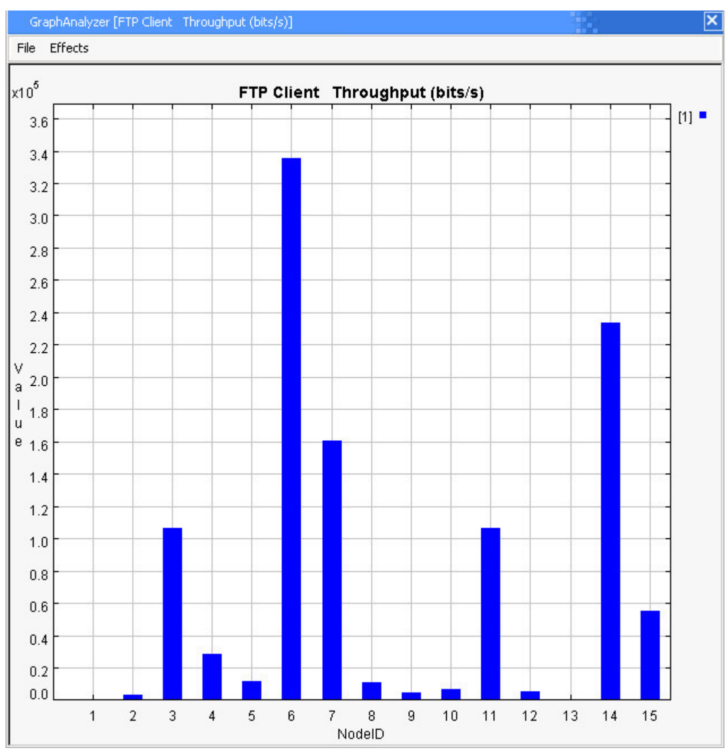

Fig 3.30 **FTP Client Throughput**

Speed= 5.5 Mbps

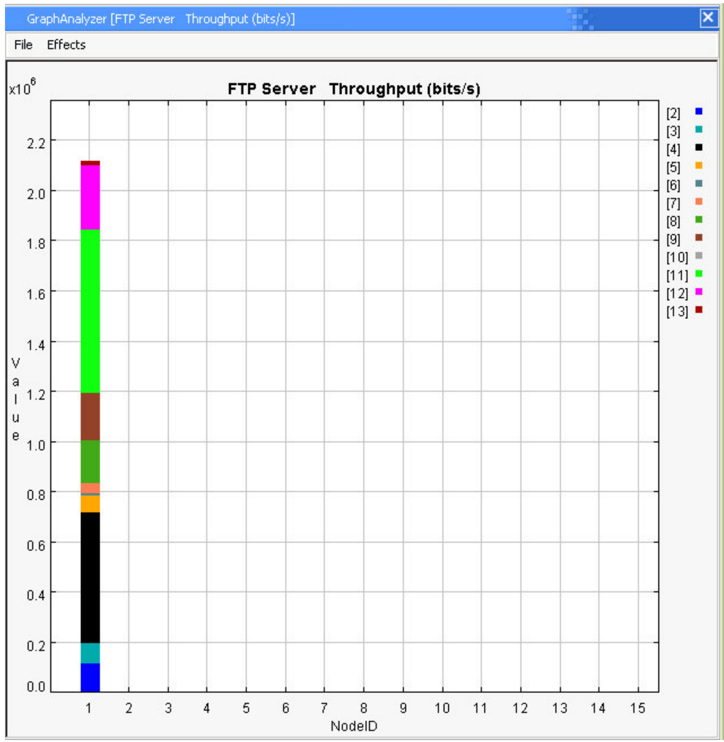

Fig 3.31 **FTP Server Throughput**

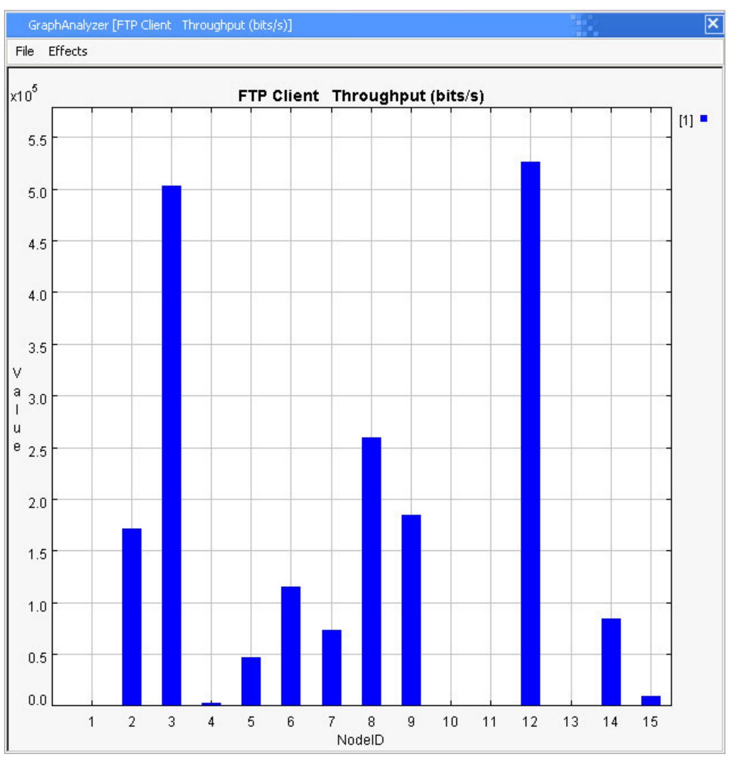

Fig 3.32 **FTP Client Throughput**

1st floor

Speed= 2 Mbps

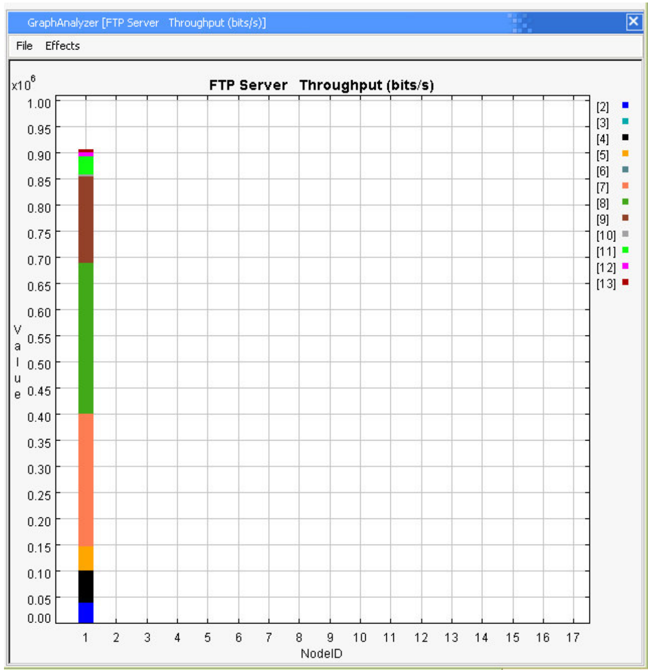

Fig 3.33 **FTP Server Throughput**

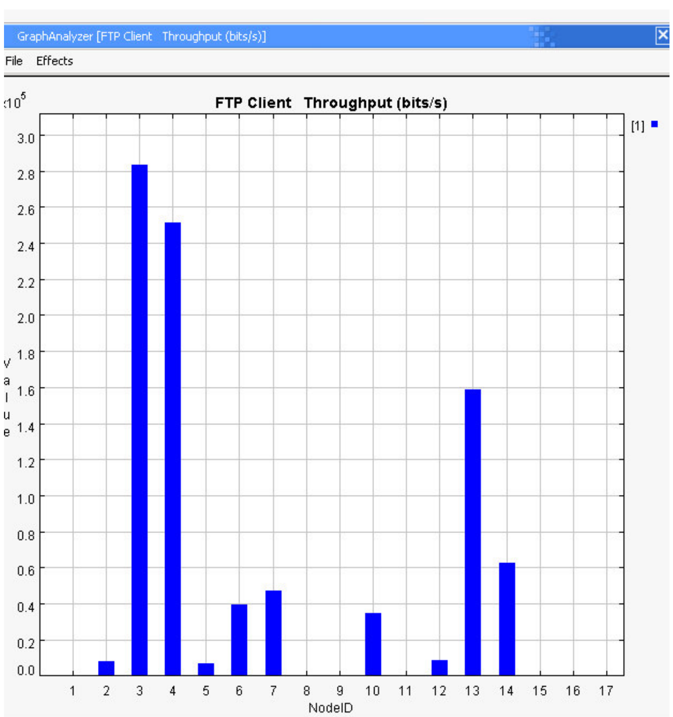

Fig 3.34 **FTP Client Throughput**

Speed=11 Mbps

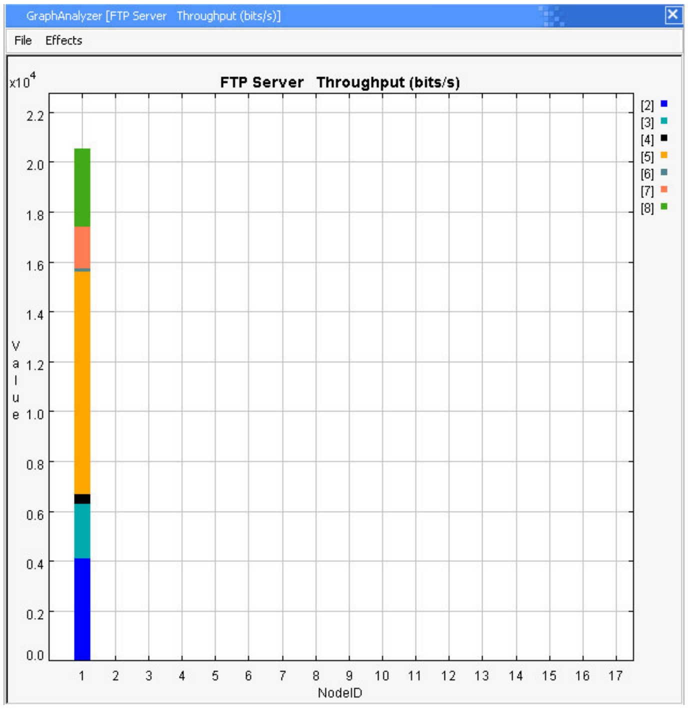

Fig 3.35 **FTP Server Throughput**

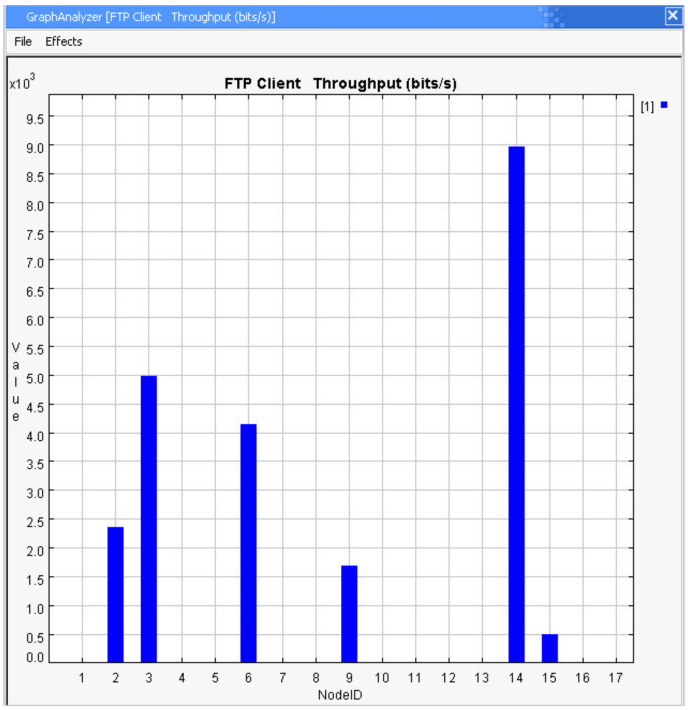

Fig 3.36 **FTP Client Throughput**

Analysis:

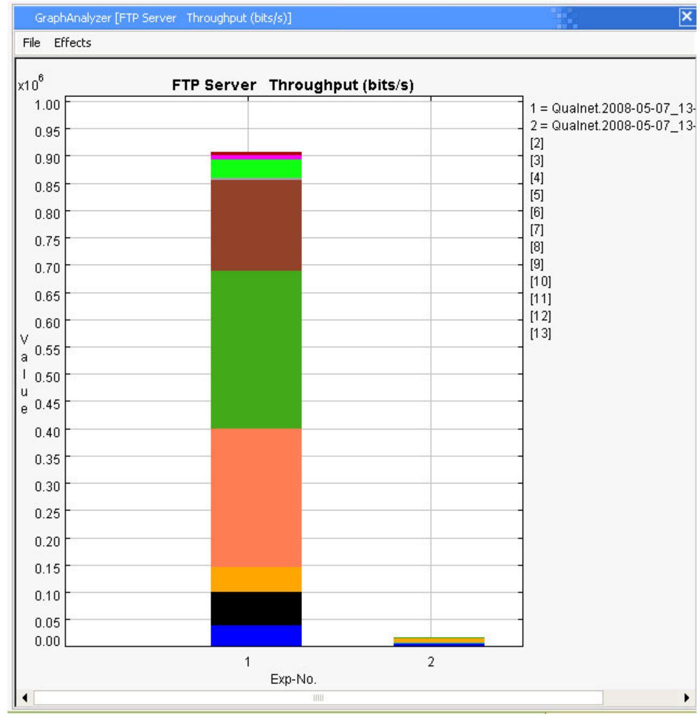

Fig 3.37 **FTP Server Throughput**

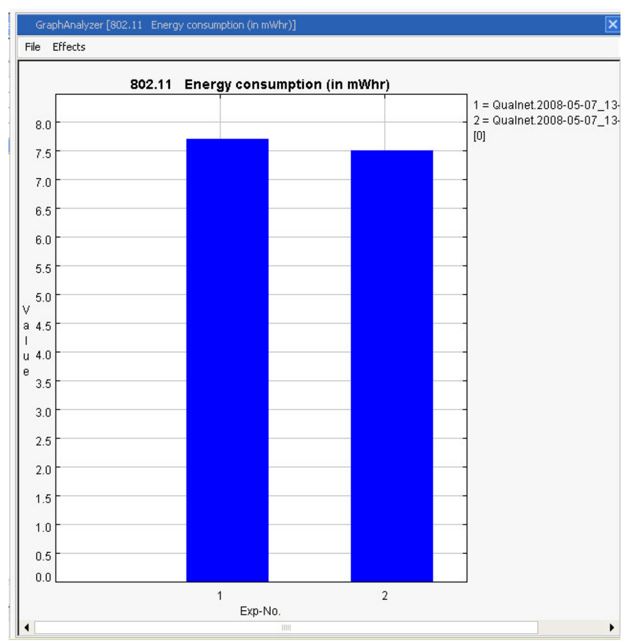

Fig 3.38 **Energy Consumption (in mWhr)**

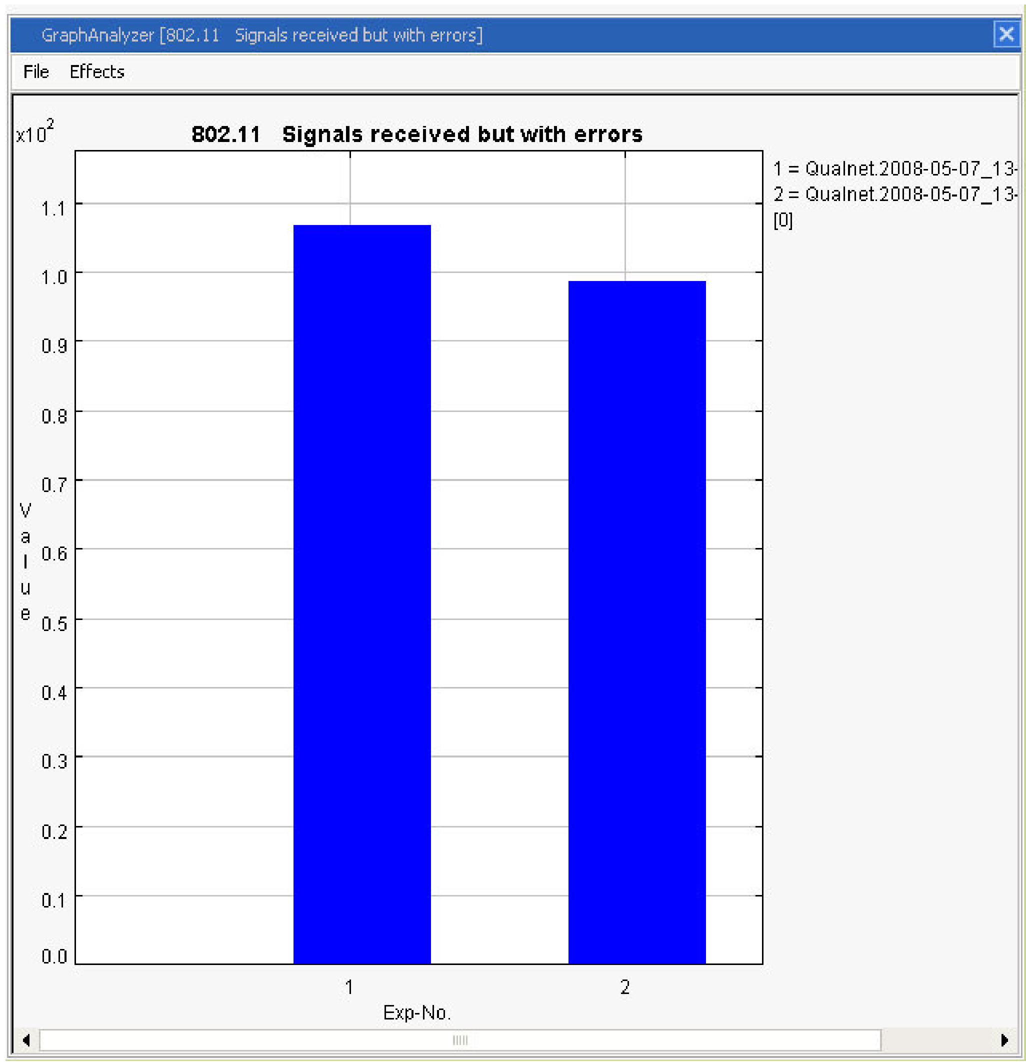

Fig 3.39 **Signals Received (with errors)**

Note: here 1= 1 Mbps and 2= 11 Mbps.

When **2 Access Points** are placed in the A-block, then the following graphs are obtained:

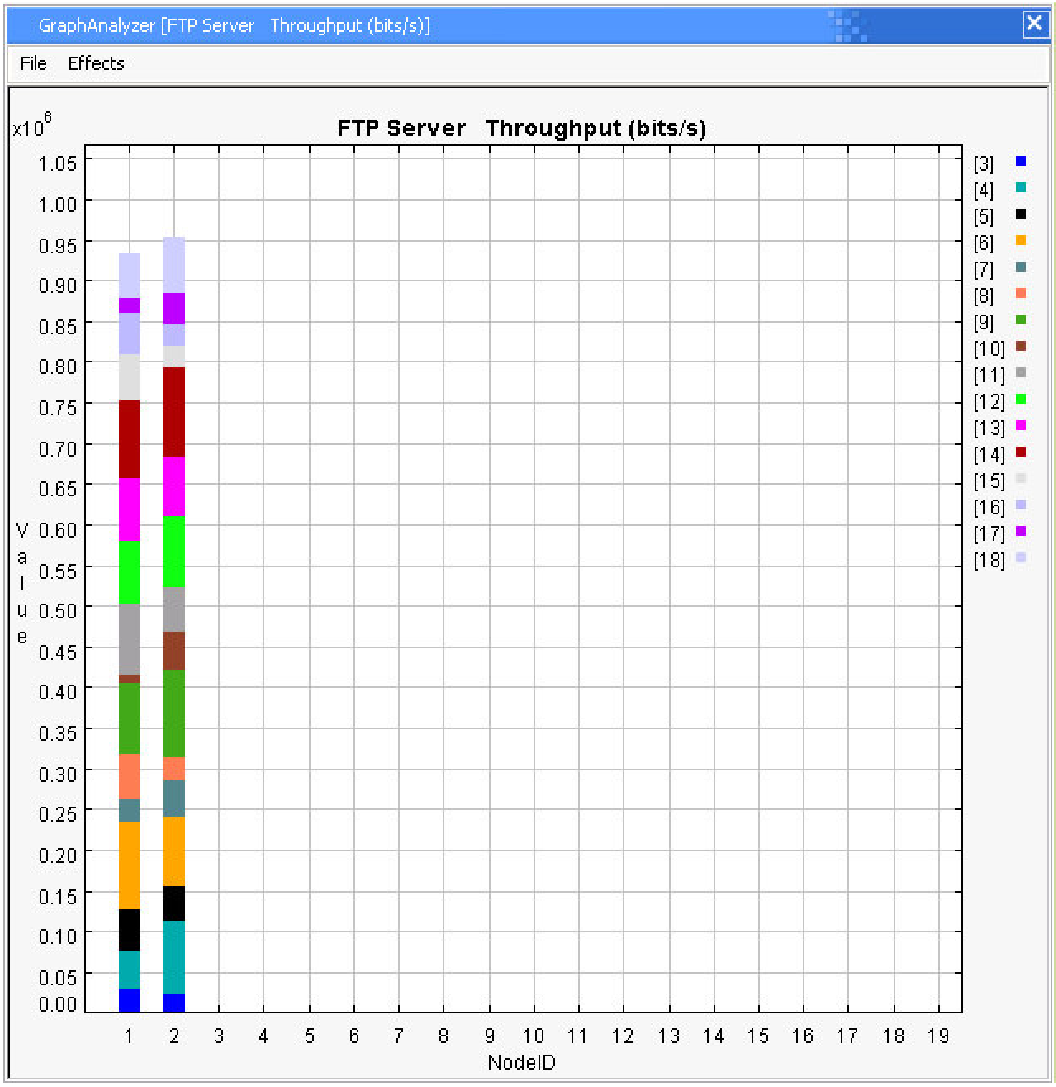

Fig 3.40 <u>**FTP Server Throughput**</u>

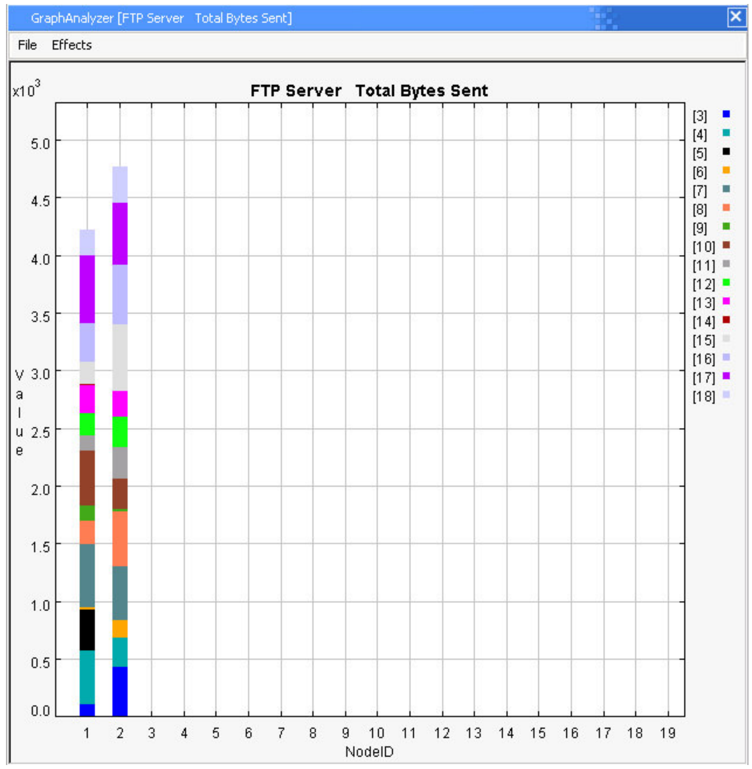

Fig 3.41 **FTP Server Total bytes sent**

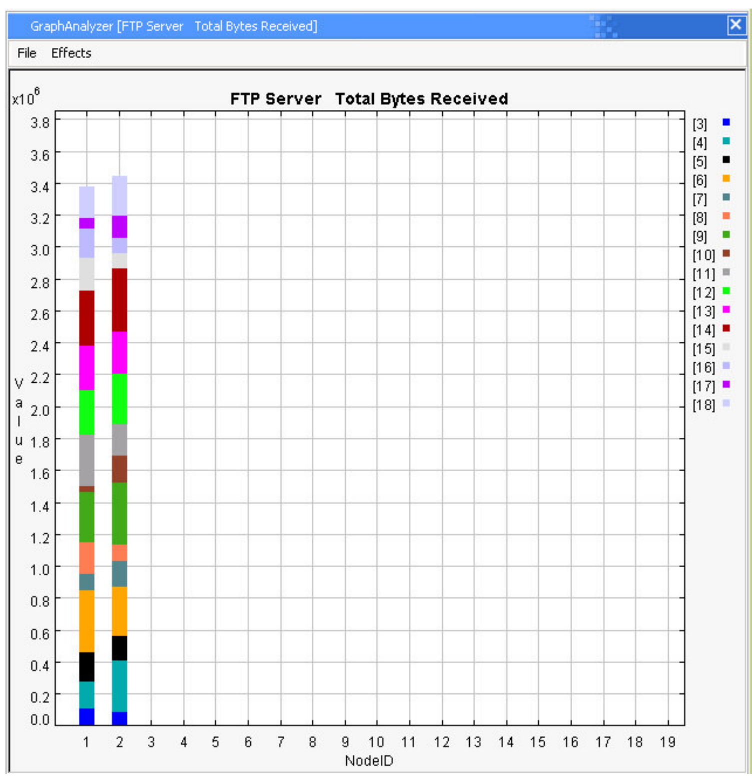

Fig 3.42 **FTP Client Total bytes received**

CONCLUSION

A bottleneck, in a communications context, is a point in the enterprise where the flow of data is impaired or stopped entirely. Effectively, there isn't enough data handling capacity to handle the current volume of traffic. A bottleneck can occur in the user network or storage fabric or within servers where there is excessive contention for internal server resources, such as CPU processing power, memory, or I/O (input/output). As a result, data flow slows down to the speed of the slowest point in the data path. This slow down affects application performance, especially for databases and other heavy transactional applications, and can even cause some applications to crash.

Thus even when two access points where used there was not much improvement in the throughput of the Wlan as shown in the simulation using two access points. Because of the bottleneck effect the throughput which was expected to increase it was actually less than the throughput obtained for using one access point.

Various data rate obtained in real time by downloading 19.9 MB file from the intranet of the NIT Rourkela when one access point was placed in the K M SHAW Hall of residence are

Ground floor

Data rate - 48.6 KB/s

First floor

Data rate -52.7 KB/s

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